The Role of Virtual Doctor Server on Wireless Body Area Network

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Abstract- **In health services the Wireless Body Area Network has gained much interest due to wide range of utility and vital role to improve human health. WBAN is very useful emerging technology having immense utilities and benefits in daily life not only for Healthcare but also for Athletic training, Public safety, Consumer electronics, secure authentication and Safeguarding of uniformed personnel. In our project, we are conducting comprehensive survey of Wireless Body Area Network (WBAN) and also introducing a Virtual Doctor Server (VDS) in existing WBAN architecture. Existing architecture of WBAN consist of wireless sensors, wireless actuator node, wireless central unit and wireless Personal Device (PD). Personal Digital Assistant (PDA) or smart phones can be used as a PD. We propose a design concept for a Virtual Doctor Server (VDS) to support various patient health care services such as cancer, diabetes, high blood pressure. VDS will keep the historical data about the patient, generate the daily tips, call the doctor or emergency service if required and can provide first aid assistance instruction on patient or any of his close relative's PDA's.**

Keywords-Wireless Body Area Network (WBAN); Virtual Doctor Server (VDS); Personal Device (PD) ; Personal Digital Assistant (PDA).

I. INTRODUCTION

BAN is also called as Body Sensor Network (BSN). BSN is becoming very important aspect in the human's life. As the technologies based on BSN are increasing day by day. In medical healthcare system it can be used as patient monitoring. For medical monitoring system it requires some kind of hardware resources, sensors etc. also the network will be formed of sensors and hardware for solving the problems in healthcare system. BAN consists of sensor node, battery and processor.

Various advantages are taken for other wireless communication standards from IEEE 802.16 Group 6 [1]. IEEE 802.15 standard is used for low range, minimum complexity, low cost and also low power consumption. IEEE 802.15.6 standard presents three aspects which focuses on physical layer (PHY), medium access layer (MAC), and security aspects [1].

BAN is used for sensing the parameter from the body of patient. The sensors are situated on the body of patient. These can be temperature sensor, ECG sensor, heart rate sensor, blood pressure sensor etc. To make the connection between the sensors and hardware device the wireless sensors are used.

The wireless technologies are the next step for improving the mobile health applications. Mobile health is also referred as mHealth and electronics health is referred as eHealth. A Wireless Body Area Network contains small and intelligent systems or devices attached to the body of the patient which is to be continuously monitored by the mobile health application over a wireless communication device which can be Zigbee or Bluetooth. WBAN provides the continuous monitoring and real time graphs and gives feedback to patient or to the doctor then the values taken are used for analysis. The analyzed values are used to check that any kind of disease will occur. The data is recorded for the long period of time.

The recent rapid progress in wireless communications has enabled the realization of low-cost miniaturized wireless sensor devices [2].These sensor devices, can be networked together over a wireless medium to form a wireless sensor network (WSN) for sensing, measuring and gathering information from the environment [2].

II. BODY AREA NETWORK (BAN)

Body Area Network now also known as IEEE 802.15.6. BAN is a network which contains sensors nodes in close on a person's body, which monitors continuously human body and even more intelligent node is capable to handle advanced signal processing. A Body Area Network is also defined as a standard for short range and wireless communication in the vicinity of a human body which provides real time monitoring system.

BAN is used in Healthcare sensor network application, BAN is used in healthcare for continuously monitoring of the patient in where various sensors are attached to the patient. Parameters are taken from various sensors nodes and then analyzed. It is comfortable for patient to make physical movement.

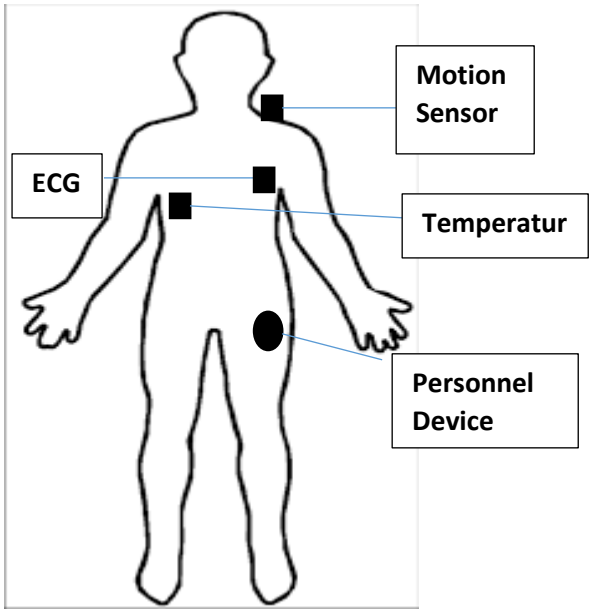


Figure 1: Patient monitoring in Wireless Body Area.

A. Types and use of different devices

a) Wireless Sensor node: A device that responds to and gathers data on physical stimuli processes the data if necessary and reports this information over the network. It consists of several devices such a sensor node, hardware tool, a power, a processor for process the data, memory for store the data and a transmitter. According to the study, one of the selective sensors used for Health care applications [2].

b) Wireless Actuator node: Next to sensing devices, the patient has actuators, which work as drug-delivery systems. Then the medicine is delivered on predetermined time, triggered by an external source (i.e. a doctor who analyzes the data) or immediately when sensors notice a problem. A node consist of a receiver for receive the data or transceiver, a power unit, memory and main component is actuator hardware (reservoir to hold the medicine and hardware to manage the medicine) [2].

c) Wireless Personal Device (PD): This device is also called a Body Control Unit (BCU). PD can be a dedicated unit or in some implementations, a Personal Digital Assistant (PDA) or smart phone is used. The Main purpose of this unit is to collect all the information attained by the sensors and actuators and communicate it to the user (patient, nurse, etc.) via an external gateway. The main components are a power unit, processor, memory and a transceiver [2].

B. Network Requirements:

Requirement specification for BAN depends on range of network, interference between nodes, proper network density, quick transmission, in body environment, encryption, security or Quality of services, reliability, enabling priority, support for different data rates, and compatibility with other PANs. Range for sensing depends on devices used in BSN. For Bluetooth range is up to 10 meters and it also depends on Bluetooth configuration, for ZigBee device it is 100 meter. Network density is 2-4 networks per meter square. Sensors used per network are 256 or less than 256 devices per network as per BAN standardization group.

C. *Hardware Requirements:*

Hardware requirements specification depends on applications of the sensor network. These are ultra-low power consumption energy, lifetime of nodes, minimum cost and minimum complexity. By using ultra low power energy consumption battery backup is improved so there is no need to change the batteries. Sensors used for mobility and monitoring patient body. Sensors or hardware to be used should be of low cost as the purpose is to provide a technology to the people to get cheaper rate monitoring and also includes minimum complexity of hardware for the people who do not like technology because they think it is difficult to handle[3].

Body areas sensors are composed by:

- Sensor which is used for measuring the parameters from body.
- Battery which is used to provide energy to sensors.
- Processor which is used for analysis of data and management of system.
- Antenna which is used for sending radio frequency signal. Body sensors used in BAN are in-body sensors which are implanted under skin which used to measure temperature, pressure etc. and n-body sensors are attached onto the cloths to measure ECG.

D. *Requirements For Wireless Medical Sensors*:

a) *Wear ability:* To obtain continuous health monitoring, wireless medical sensor nodes should be small in size. The size and weight of sensors is determined by the size and weight of batteries [3].

b) *Reliable Communication:* Reliable communication requirements of different medical sensors vary with required sampling rates, from less than 1 to 1000 Hz. Communication plays important role in WBAN [3].

c) *Security:* Another important issue is overall system security.

d) *Data integrity:* Data integrity are challenging tasks in resource constrained medical sensors, a small number of nodes in a typical WBAN and

short communication ranges make these tasks achievable [3].

III. WIRELESS BODY AREA NETWORK (WBAN)

Wireless body area network is also part of BAN or Wireless Body Sensor Network (WBSN).It is composed of one or more Body Sensor Units (BSU), one Body Central Unit (BCU) and work with long range network such as ZigBee or Bluetooth etc. By using latest technologies in WBAN the small sized and intelligent sensors are used in the biomedical system to improve the performance of the health care system. The sensors are connected to the small sized hardware and the data from the sensors is used to transfer. Also the data is sent to the medical server and it is analyzed over there and stored. Wired connection used for this purpose is time consuming and even much complex. Wireless connection used in the WBAN applications is easier and cost efficient. The patient can move anywhere and there is no need to be present in hospital or no need to stay under observation. By using such systems can improve the medical health care and minimizes the cost.

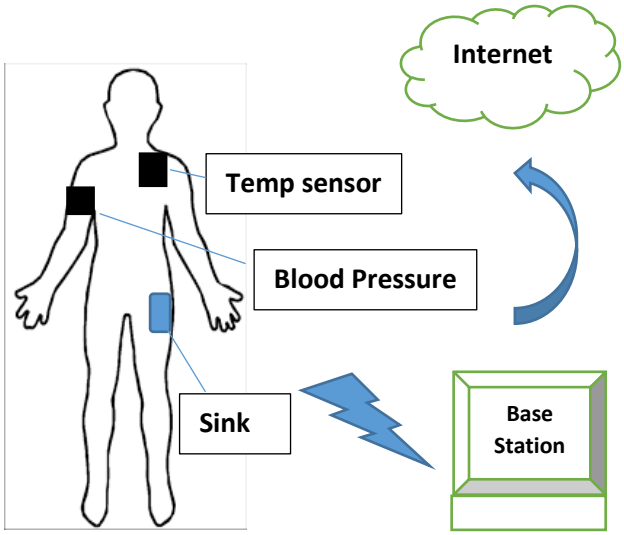


Figure 2: WBAN

A wireless body area network (WBAN) is a radio frequency (RF) based wireless networking technology that interconnects tiny nodes with sensor or actuator capabilities in, on, or around a human body [2]. As describe in the transmissions of these nodes cover a short range of about 2 m, and other specifications of WBAN are shown in Table [2].

IV. WBAN ARCHITECTURE

Tier 1 shows a number of wireless medical sensor nodes that are integrated into a WBAN. Each sensor node senses samples and process physiological signals. For example, an electroencephalogram sensor (EEG) for monitoring brain electrical activity, an electrocardiogram sensor (ECG) is used for heart activity, a blood pressure sensor used for monitoring pressure, and a breathing sensor for monitoring respiration; and motion sensors can be used to discriminate the user's status and estimate her or his level of activity.

Tier 2 shows the personal server (PS) application running on a Personal Digital Assistant (PDA), a mobile phone and personal computer. The PS has a number of functions, it provides interface to the wireless medical sensors, an interface between the user and medical server. The interface to the WBAN contains the network configuration and network management. The network configuration shows the following tasks: sensor node registration (type and number of sensors), initialization (e.g., specify sampling frequency and mode of operation), customization (e.g., run user-specific calibration, and setup of a secure communication [3]. Once the WBAN network is configured, the Personal Server manages the network configuration, it take cares of channel, time synchronization. Based on synergy of information from different medical sensors, the PS application determine the user's state and his health status and provide feedback through a user friendly and graphical or audio user interface [3].

Then, the communication channel to the medical server is available, the PS establishes a link to the medical server and sends reports that can be integrated into the user's medical record. If a link between the PS and the medical server is not established, the PS stores the data locally and initiate data uploads when a link becomes available.

Tier 3 shows a medical server(s) accessed by using the Internet. The last tier shows other servers, such as health care providers and emergency servers. The medical server runs a service that sets up a communication channel to the user's PS, then it collects the reports from the user, and integrates the data into the user's medical record. The service can alert if reports seem to indicate an abnormal condition [3].

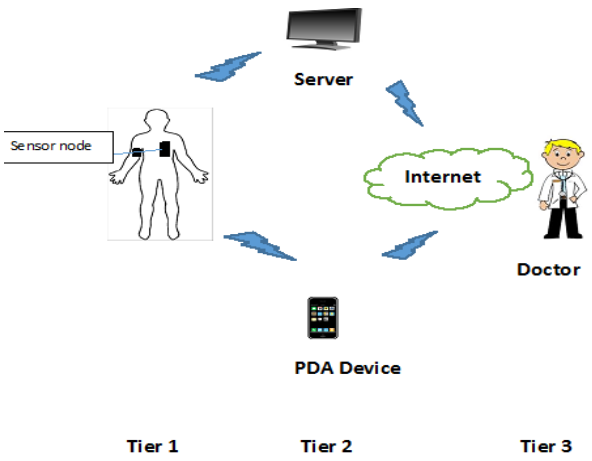


Figure 3: Architecture of WBAN

A. Wireless Technologies For WBAN

a) *Bluetooth (IEEE 802.15.1):* Bluetooth was designed as a short-range wireless communication standard, and later evolved to become a widely accepted wireless alternative for connecting a variety of personal devices. The initial revisions of Bluetooth featured a maximum data rate of 1 Mbps and ranges of up to 100 m[4].

b) *ZigBee (IEEE 802.15.4):* ZigBee defines specifications for low-rate BANs for supporting simple devices that consume minimal power and typically operate in a personal operating space (POS) of 10. ZigBee devices can operate in three ISM (industrial, scientific and medical) bands, with data rates ranging from 20 Kbps to 250 Kbps [4].

c) *UWB (IEEE 802.15.3):* UWB is a radio technology used at low energy levels for short-range, high-bandwidth communications using a large portion of the radio spectrum [4].

d) *Wi-Fi (IEEE 802.11 a/b/g):* Wi-Fi includes IEEE 802.1l a/b/g standards. It allows users to surf the Internet at broadband speeds. The maximum data rate of 802.11a and 802.11g is 54 Mbps, while 802.11b supports 11 Mbps [4].

B. Physiological Monitoring

In physiological monitoring applications, low power sensors measure and report a person's vital signs (e.g., respiration rate, temperature). These applications can be developed and deployed in different contexts ranging from disaster response, to in-hospital patient monitoring, and long-term remote monitoring for the elderly [7].

In WBAN, small and intelligent medical sensors can be worn on, around or implanted in the human body to monitor human physiological activities and actions, such as health status and motion pattern [8].

The patient's physiological signals are acquired by the sensors attached on the patient body, and are then transmitted to the remote base-station and also a PC for storing and analyzing. In indoor environments, the signal strength of access points can be weakened by 30-90% as it passes through the obstructions. With the increasing number of obstructions between the sensor nodes, we can observe packet loss and more dead spot that will cause a communication disconnection between the patient and the network. So, we have to increase the number of sensor node within the environments to cover the whole environment. An emergency alert service using short message service (SMS) messaging is also added to the proposed system for emergency and rescues [9].

IV. PROPOSED METHDOLOGY

In WBAN, support vector machines (SVM) a supervised learning model with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier.

A. Binary classifier

Given a family of healthy/disease parameters as ECG we denote x a parameter vector and xj its jth coordinate. We will build a binary classifier C(x), trained from a set of labeled parameter examples collected previously. In order to build the most efficient-robust and fast classifier possible, we will investigate two well-known approaches, the geometric support-vector-machine (SVM) method [1].

B. *SVM classifier*

For each patient from the learning sample, the label, denoted Y, is a random variable getting a value 1 if the patient is ill and −1if the patient is healthy. The parameter vector X ∈ Rd is a random vector of dimension d, the number of parameters. We observe on each patient i = 1,…n from the learning sample of size n both Y and X, and we denote yi and xi respectively the values of Y and X observed on the individual. SVM algorithm consists in estimating the parameters of the decision function C(x) during a learning phase from the learning sample data (x1, y1) After training, based only on the observed values x of its parameter vector X, the classification of a new patient (to the group of ill patients or to the group of healthy patients) is predicted according to the decision rule [1].

C. *Example of SVM classifier.*

If all three symptoms accrued in the same time we can say this person is infected

Proof: M = Mote
Mi =3 = {M0, M1, M2}
And if,
$\sum$ m>2, infected
and
Person (i) = {1, if m>2, infected}

{0, if m <2, not infected}

For example:
Person (i), has 3 motes
and
if $\sum$ m>2, infected
His body sensor shows that:
M0: [1] skin temp= 40 C
M1: [2] Body motion <1

M2: [3] Blood Pressure= 90 C/min.

Mi=3: {M0,M1,M2}

The input values are converted into binary codes (zero=off, one=on)

M0=1, (40 C)
M1=1,(<1)
M2=1, (90 C/min =1.)

So, the result of patient are follows
M= 1+1+1=3, so this person is infected.

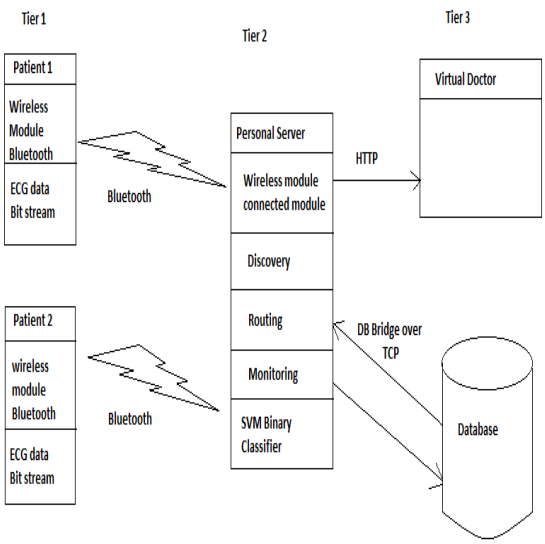


Figure 4: Proposed Architecture of WBAN.

a) Tier 1:

Tier 1 has wearable sensor device placed on patient body and which acts a Bluetooth for communication with personal server. A typical WBAN system consists of multiple sensor nodes and a single receiver node (i.e. control unit) attached to each user. Although the locations of the sensor nodes are generally fixed, depending on the specific physiological signals to be measured, the receiver position (the controller unit), on the other hand, is not fixed. It is normally placed at a location identified by the system designer or at a location that enhances the user's comfort level [10].

b) Tier 2:

Tier 2 has personal server, and it is computer software could be installed on a personal computer. These are full function devices. And they can communicate with external network by using HTTP server and communication between personal server and database server is done by using Database Bridge over TCP.

c) Tier 3:

Tier 3 includes a medical server(s) accessed via the HTTP. It encompasses a network of remote server which is the remote application to which data or information is transferred. Which is the database server located in the medical institution, which stores the patient's primary information like patient ID, patient name then it stores parameter of analysis and diagnosis result.

This system can be used at home or in hospitals to form a remote medical system among home, community and hospital. The sensors collect the data and send the collected data to the remote central server through many ways, such as RS232 which is connected to a local computer connected to internet, GSM and so on. The doctors have a possibility to review and analyze their medical data in their surgeries. And the patients can also see the doctor at home. The sensor node collects the data of the patient real-time and transmits the data to the sink node [11].

D. *Flow Diagram*

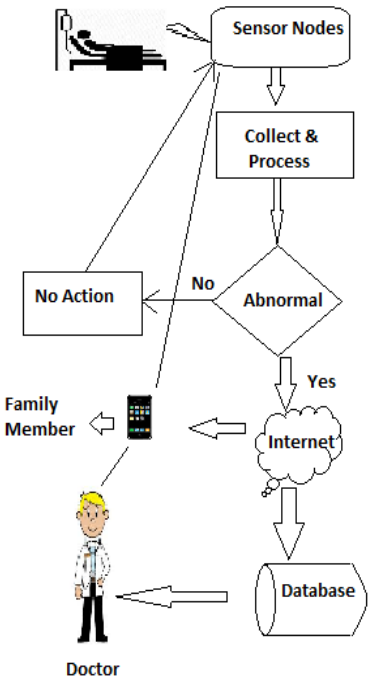
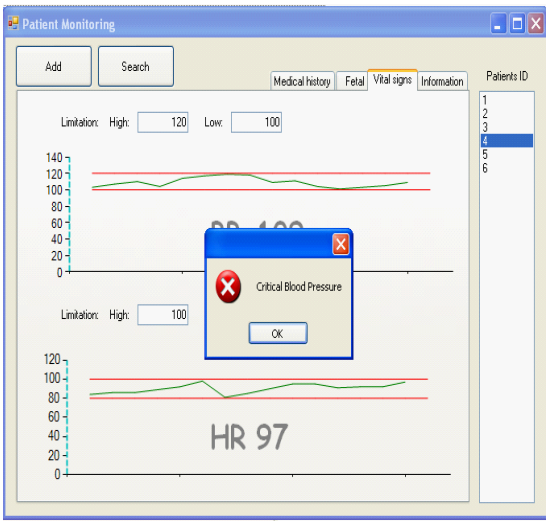


Figure 5: Flow Diagram

As illustrated in flow diagram (Fig.5) sensor node senses the parameter from patient's body and after processing it will detects the patient is abnormal or not, if parameters are normal then it won't take any action but if parameters are abnormal then it sends the message, informing doctor about the status of health parameters, as well saves that entire information into the database.

VI. IMPLEMENTATION DETAILS

Effectiveness of proposed system will be analyzed on test dataset containing information about various health parameters and the result will be shown as follow.



VII. CONCLUSION

The aim of this paper is to investigate the role of WBAN in improving human Quality of life. In this project, we tried to scan all possible application of WBAN in daily life, the challenges WBAN facing nowadays and open research issues. We proposed a new component VSD. WBAN is very useful emerging technology having immense utilities and benefits in daily life not only for Healthcare but also for other applications. The challenges and open research area discussed in this project will be considered as a source of inspiration for future research directions. And this system provides low cost and proper communication channel for transfer the data which helps for early dieses diagnosis.

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